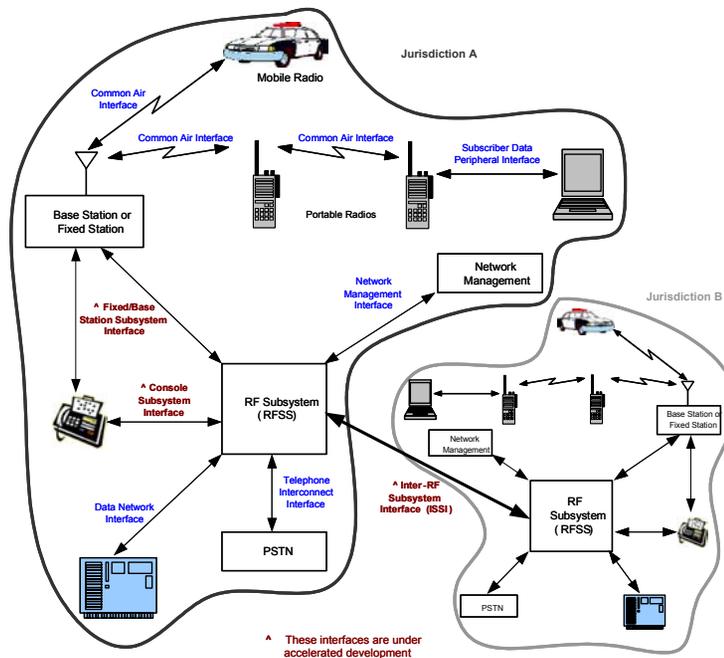
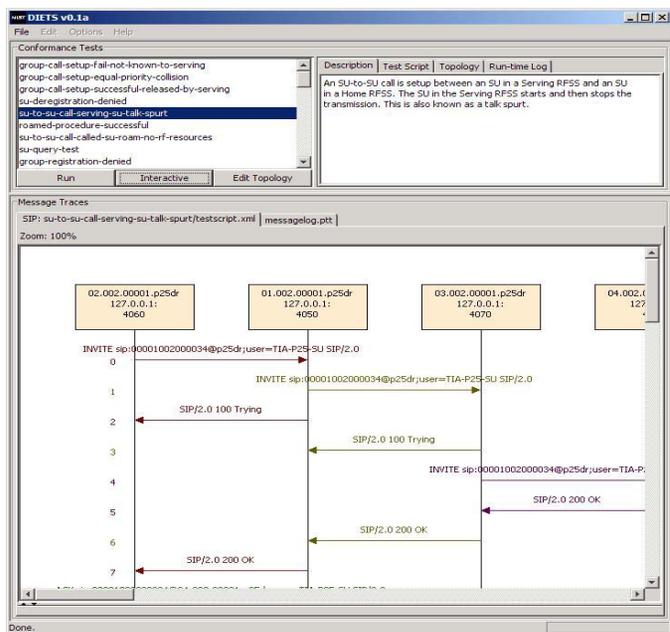


Test and Measurement of Project 25 Digital Interfaces



M. Ranganathan, S. Quirolgico,
D. Montgomery (dougmn@nist.gov)
K. Behnam (ITS), D.J. Atkinson (ITS)



Interoperable Public Safety Communications

What is the problem?

- Lack of PSC interoperability is costing lives ...
 - Post 9/11 – interoperability of public safety communications systems becomes a national priority.
 - Continued failures during Katrina (9/2005) raise the urgency.

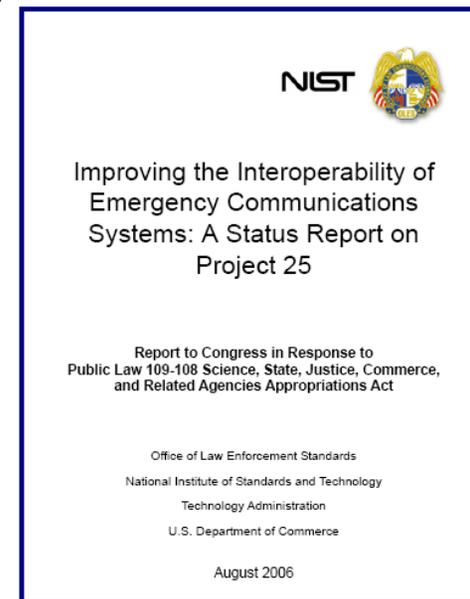


What is the proposed solution and NIST's role in it?

- **NIST** and **NTIA's** Institute for Telecommunications Sciences (ITS) are working with **DHS' SAFECOM** Program to support the emergency response community and industry in their effort to accelerate the development of **Project 25** (P25) standards for interoperable communications.

What is the problem with the solution?

- P25 progress has been slow.
- NIST has submitted a report to Congress on accelerating P25 standards as required by the FY2006 Appropriations Act for Commerce, Justice, Science, and Related Agencies.
 - **Accelerated interface standards are a key element to building a system of systems.**
- NIST is also working with NIST and the Department of Justice to develop a P25 compliance assessment program.



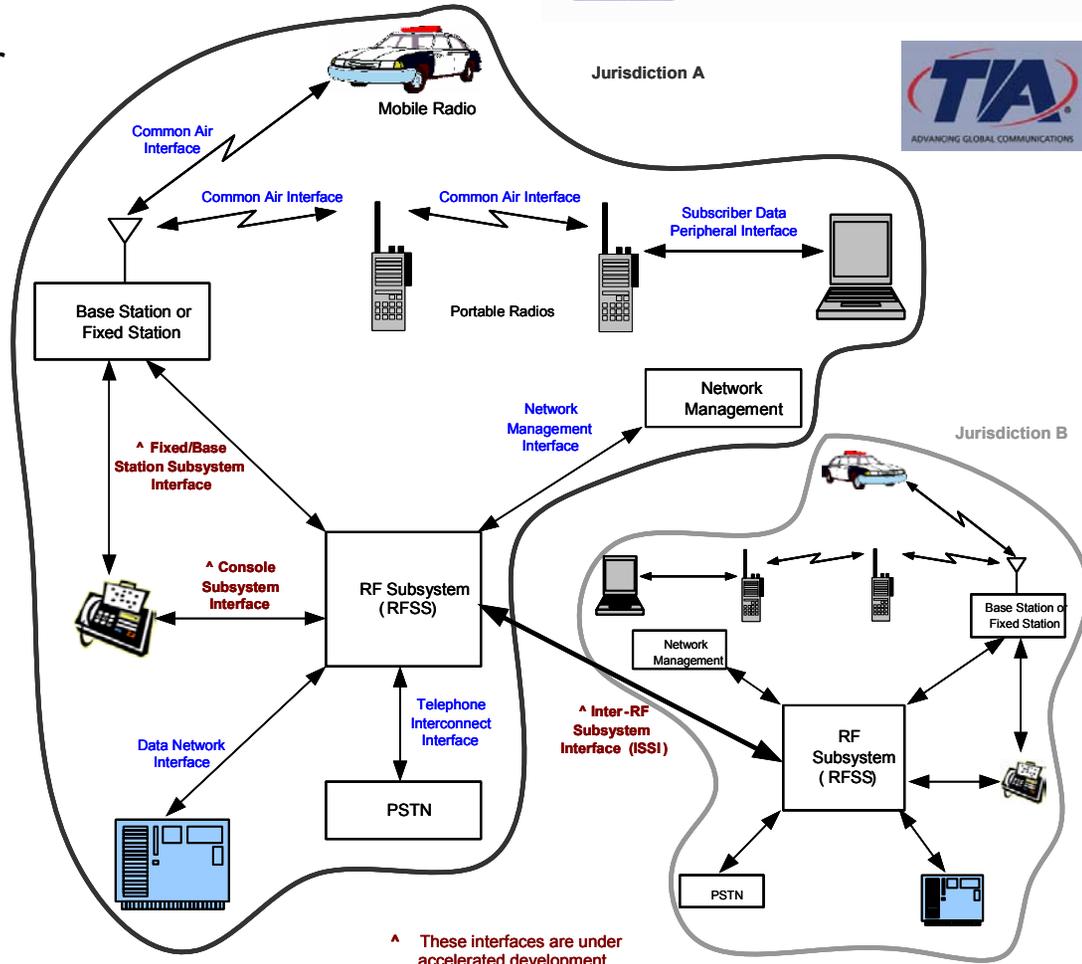
Project 25



APCO International
Association of Public-Safety Communications Officials International, Inc.

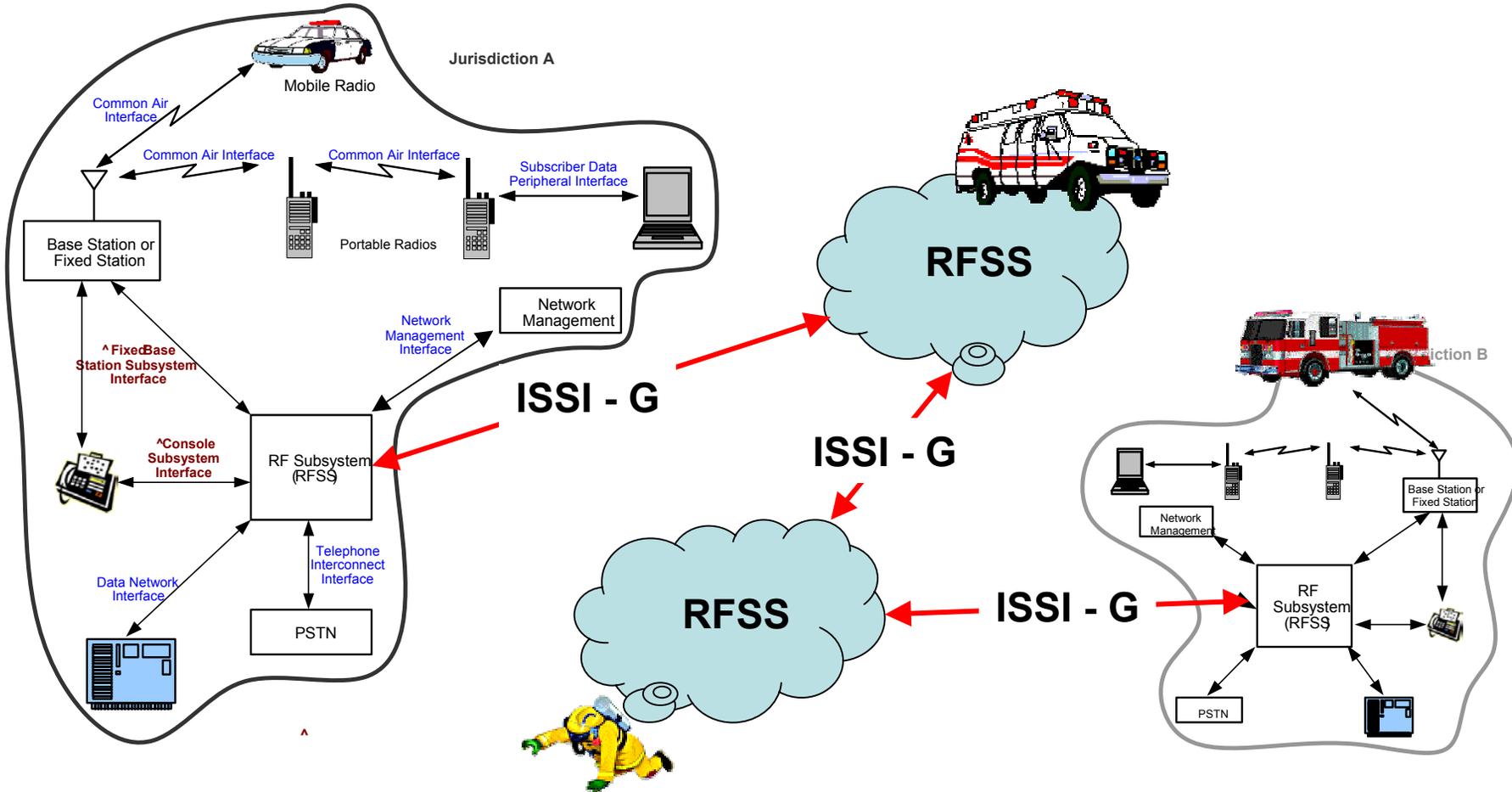


- **P25/TIA Partnership**
 - Established – 1993.
 - P25 – user/vendor consensus standards for land mobile radio (LMR)
 - TIA/TR-8 Mobile and Personal Private Radio Standards.
- **USG acceleration:**
 - Inter-RF-SubSystem Interface (ISSI)
 - Conventional Fixed Station Interface (CFSI)
 - Console Subsystem Interface (CSI).
- **Compliance Program:**
 - NIST/DHS/DoJ developing programs to assure conformance, interoperability and performance.



^ These interfaces are under accelerated development

Inter RF Sub-System Interface (ISSI)

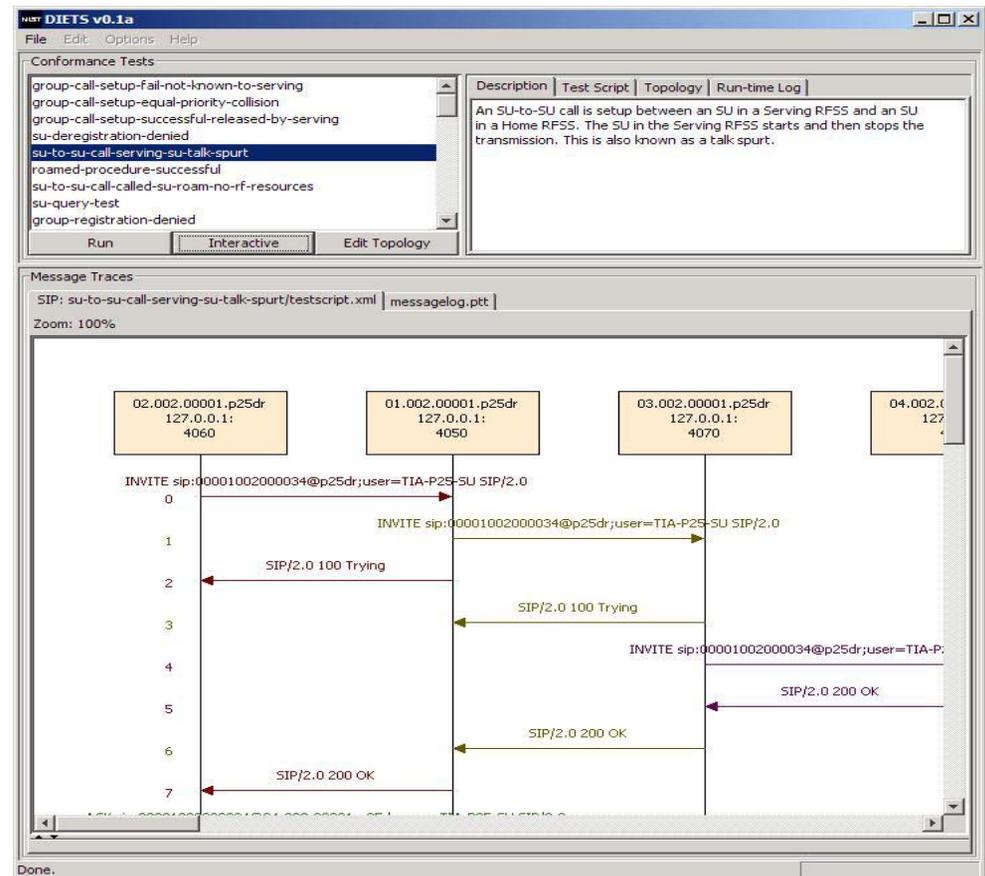


- **Key to near term inter-operability**
 - Bridge between potentially non-interoperable RF systems.
- **SIP Call Control Signaling with RTP Push to Talk (PTT).**
 - Registration, mobility, group and unicast calls.

ANTD's Role

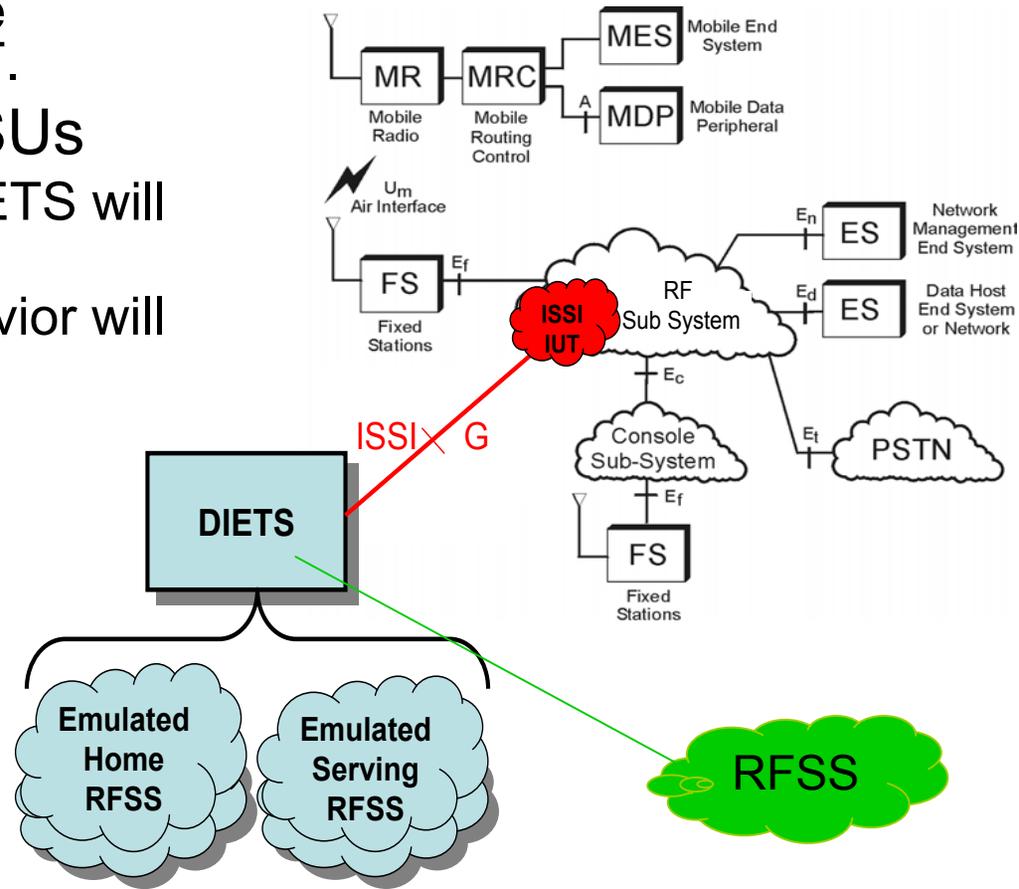
Dept of Commerce ISSI Evaluation and Test System (DIETS)

- ISSI USG Priority
 - Expedite Standards
 - Expedite testing technology.
 - Expedite commercial implementations
- ITS/OLES
 - Leverage ANTD experience in IP Telephony technologies and their test and measurement tools.
- DIETS
 - ISSI Reference Implementation.
 - ISSI test and evaluation framework.



DIETS Scope and Focus

- Live ISSI-G Interface
 - Primary focus of the test system.
 - DIETS will appear as a live ISSI/RFSS interface to IUT.
- Emulated Local RFSSs/SUs
 - RFSS behavior behind DIETS will be emulated.
 - Subscriber Unit (SU) behavior will be emulated.
 - Subscription
 - Mobility
 - Group / Unicast calls.
- Other Testing
 - Performance
 - Behavior
 - Test Design



What we are / aren't building?

ARE:

- DoC ISSI Evaluation and Test System (DIETS):
 - We are building a evaluation and test framework for emerging implementations of the ISSI protocol as defined in project P25 ISSI Msg Proc.
 - Behavior, Performance, Interoperability and Conformance tests.
- Approach: Instrumented Reference Implementation (RI) embedded in test framework.
 - Availability of open source RI component will expedite commercial ISSI implementations and foster competition.
 - Availability of RI and test system will also serve as a research platform for testbed evaluations of future ISSI design alternatives.

NOT:

- A complete test system for SIP
 - Nor, a production level SIP Stack.
- A complete test system for RTP
 - Nor, a production level RTP Stack
- A tester of RFSS internals
 - Codecs, air interfaces, etc.

“Testing” in the P25 World

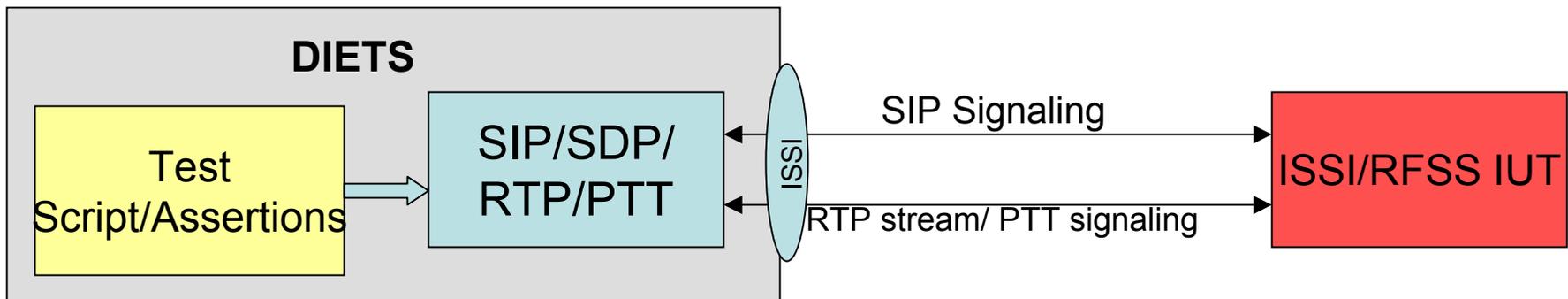
- Types of Testing
 - **Reference** Testing : An RFSS under test (IUT) interacts with a standard or “reference” RFSS. **RFSSs are tested in Isolation.**
 - Subsystem **Interoperability**: RFSSs (from the same vendor or different vendors) interact with each other (or the Reference Implementation) and run a scenario.
 - **Conformance**: ? USG compliance testing program will have to define how the types above (plus other types?) will be used to test compliance.

DIETS: Functional Goals

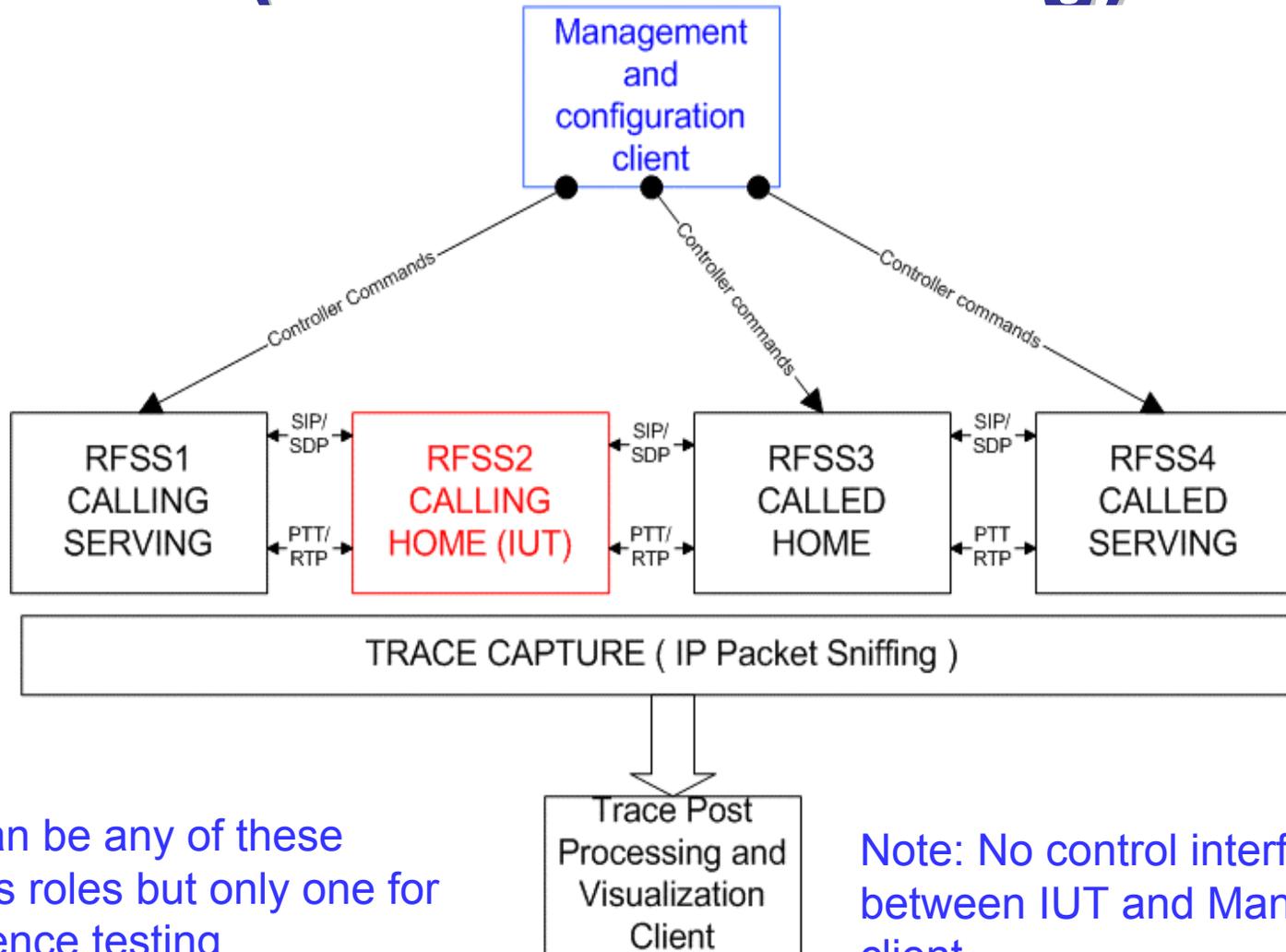
- Protocol Emulation:
 - A protocol emulator to exercise (live test) the protocols defined in the ISSI Specification document.
 - The purpose is to provide a stand alone emulation of the scenarios described in the call flows section (appendix C of the ISSI specification) and the test cases defined in the TIA/ISSI test document.
 - Stand alone emulation helps identify bugs in the specification and test cases (has already resulted in spec clarifications).
- Reference Testing:
 - A test tool to interact with vendor developed RFSSs and verify correct operation of the IUT:
 - The purpose of reference testing is to analyze vendor implementations in isolation by treating them as a “black box” and analyzing interactions between the vendor Implementation and a RI (i.e. Signaling Emulation Test Tool).
- Protocol Analysis:
 - A packet capture and visualization tool to display the interactions between RFSSs captured during interoperability testing.
 - The primary purpose of trace capture and visualization is diagnostic.
 - DIETS will provide tools that can capture (log) the interactions between vendor-developed or Reference RFSSs and that can display these as signaling traces.

How the System Works

- Emulated/scripted Subscriber Unit (SU) behavior will drive the DIETS to exercise all aspects of the interface described in the ISSI specification.
 - The SU behavior will be emulated at the level of signaling at the RFSS.
- Vendor ISSI/RFSS Implementations Under Test (IUT) will interface through live protocol exchanges with the test system.
 - DIETS will test for required ISSI protocol from IUT.



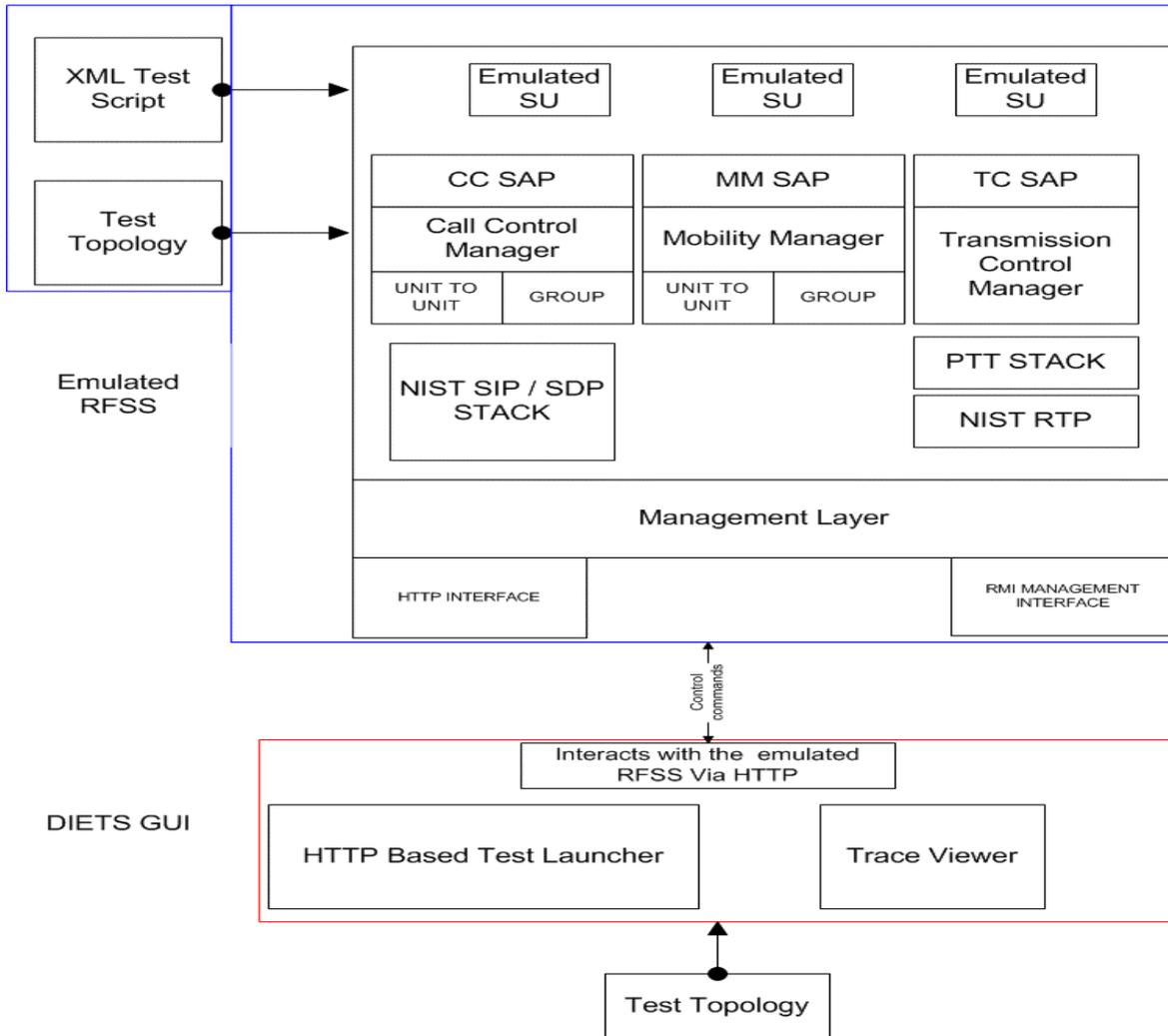
Distributed Architecture (Reference testing)



IUT can be any of these RFSSs roles but only one for Reference testing

Note: No control interface between IUT and Management client

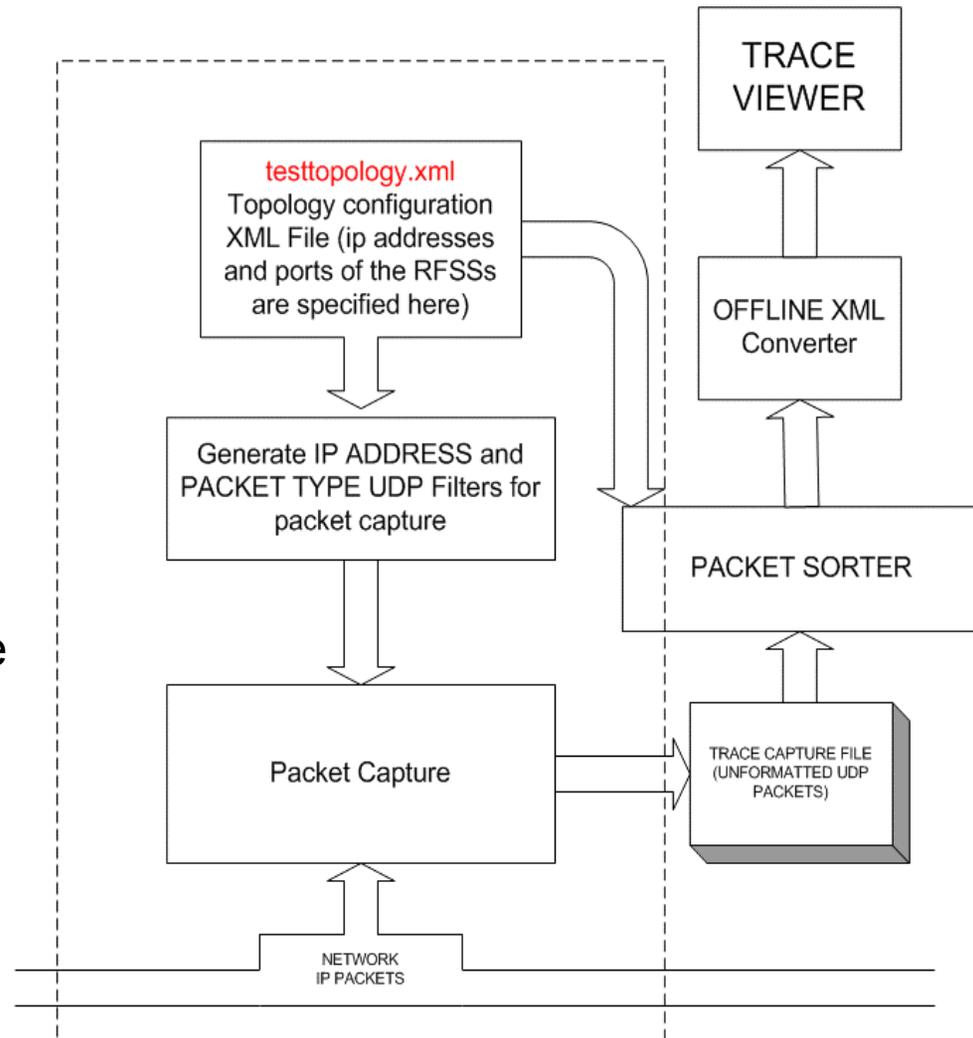
DIETS Architecture



•All Interactions with Emulated RFSS are via HTTP.

ITAT: ISSI Trace Analysis Tool

- Emulation and Live Testing
 - Captures/retrieves packet traces from emulated RFSSs and live off of the wire.
- Stateful packet sniffing
 - The packet sniffer needs to have knowledge about the endpoints (IP addresses) and ports to which packets are headed.
 - Unfortunately the ports for the PTT traffic is not known a-priori. This port exchange is part of the SIP call setup.
 - The Packet Sniffer has to be call stateful (Aware of successful call setup).



DIETS Test Suites

- **XML Test Cases**

- Topology information
- RFSS / SU parameters
- Scripted behavior
- Test predicates
- IMBE voice files

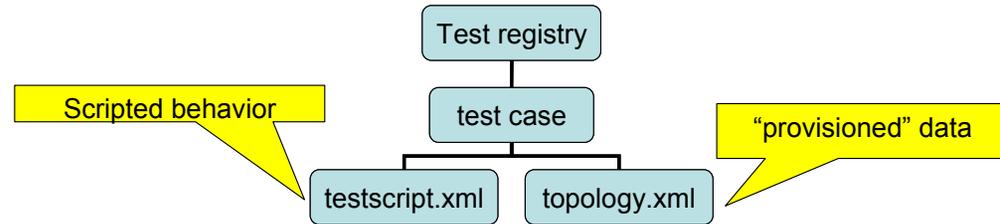
- **Test Suites**

- Repository of test cases.
- ~100 ISSI standard conformance test cases.

- **Test Execution:**

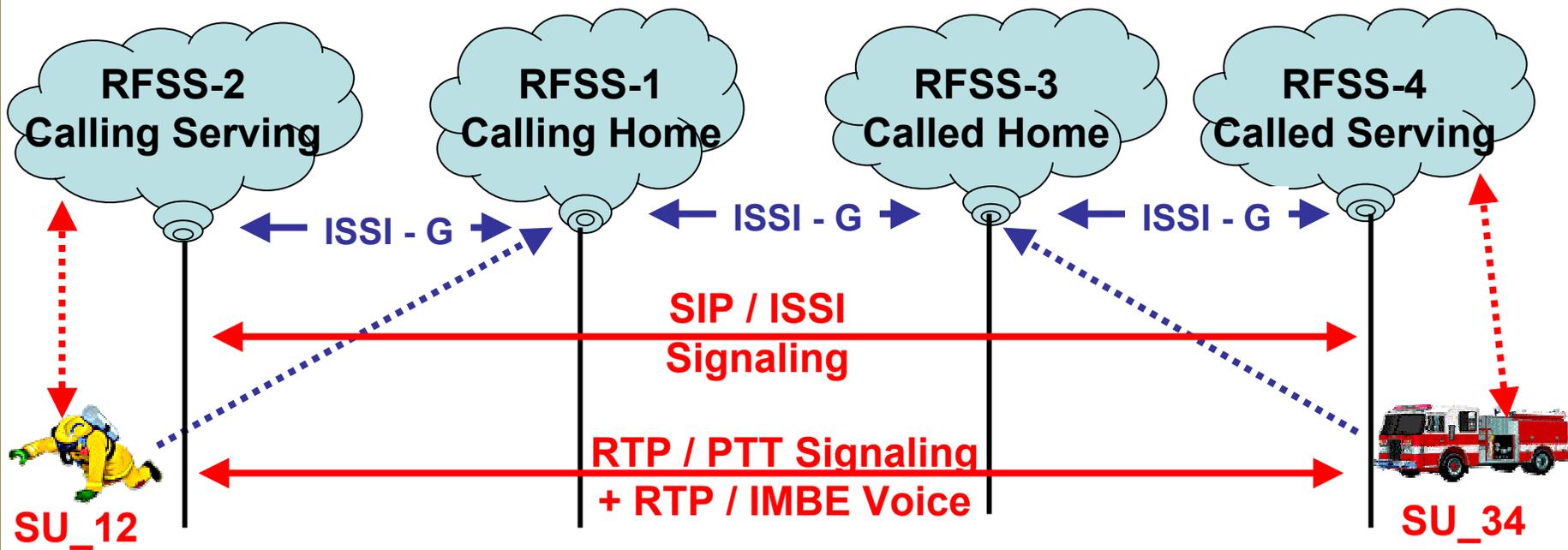
- There is no inter-RFSS test coordination once a test is initiated. All test actions are time based.
- Each emulated RFSS loads and runs the same test case.
- The only exchanges between DIETS sub-components are live ISSI Protocol Exchanges.
- This allows for free substitution of live components in any role.

- **Easier to see in a demo ...**



```
<wacn-config
    wacnName = "wacn_0001"
    wacnId = "0001"
/>
<systemconfig
    systemName = "system_2"
    systemId = "0002"
/>
<!-- The Following describe the
RFSSs in the system. -->
<rfssconfig
    rfssName= "rfss_1"
    ipAddress ="127.0.0.1"
    port = "4050"
    rfssId = "1"
    emulated="true"
/>
```

DIETS Demonstration:



- **Scenario: SU-to-SU Call between units that have roamed.**
 - SU_12 is homed to RFSS-1, but has roamed to RFSS-2
 - SU_34 is homed to RFSS-3, but has roamed to RFSS-4
 - Demo of successful ISSI/PTT talk spurt between initiated from SU_12 to SU_34.
- **Self test for demonstration.**
 - Useful for designing, debugging and documenting test suite.
 - In live test commercial ISSI IUT could replace any RFSS role in the scenario.

PSC P25 Impacts

Some Recent Examples:

- **Leading the development of key standards:**
 - TIA 102 BACA : *ISSI Messages and Procedures*
 - DRAFT - *Project 25 Inter RF Subsystem Interface Conformance Test Procedure*,
 - DRAFT - *Project 25 Fixed Station Interface Conformance Test Procedure*,
 - TIA 102.CACA *ISSI Measurement Methods for Voice Services*,
 - TIA-102.BACD *Messages and Procedures for Supplementary Data over the ISSI*
- **Analysis and tools to expedite industry adoption:**
 - *Test and measurement tools for Project 25 Digital Interfaces*, M. Ranganathan and S. Quirologico, <http://www-x.antd.nist.gov/proj25/>
- **Recent Collaborations:**
 - NTIA / Institute for Telecommunications Sciences (ITS)
 - NIST / Office of Law Enforcement Standards (OLES).
 - DHS SAFECOMM Program
 - Telecommunications Industry Association (TIA) Project 25
 - Association of Public-Safety Communications Officials (APCO) Inter
 - Industrial collaborators: EADS, Motorola



APCO International
Association of Public-Safety Communications Officials International, Inc.



Questions / Discussions?

Following Material Not Presented:

NIST DIETS v0.1a

File Edit Options Help

Conformance Tests

- group-call-setup-fail-not-known-to-serving
- group-call-setup-equal-priority-collision
- group-call-setup-successful-released-by-serving
- su-deregistration-denied
- su-to-su-call-serving-su-talk-spurt**
- roamed-procedure-successful
- su-to-su-call-called-su-roam-no-rf-resources
- su-query-test
- group-registration-denied

Run Interactive Edit Topology

Description Test Script Topology Run-time Log

An SU-to-SU call is setup between an SU in a Serving RFSS and an SU in a Home RFSS. The SU in the Serving RFSS starts and then stops the transmission. This is also known as a talk spurt.

Message Traces

SIP: su-to-su-call-serving-su-talk-spurt/testscript.xml | messagelog.ptt |

Zoom: 100%

02.002.00001.p25dr
127.0.0.1:
4060

01.002.00001.p25dr
127.0.0.1:
4050

03.002.00001.p25dr
127.0.0.1:
4070

04.002.00001.p25dr
127.0.0.1:
4080

INVITE sip:00001002000034@p25dr;user=TIA-P25-SU SIP/2.0

0

1

2

3

4

5

6

7

SIP/2.0 100 Trying

SIP/2.0 100 Trying

INVITE sip:00001002000034@p25dr;user=TIA-P25-SU SIP/2.0

SIP/2.0 200 OK

SIP/2.0 200 OK

SIP/2.0 200 OK

Done.

Topology Configuration

```
<?xml version="1.0" ?>  
<!DOCTYPE issi-tester-config  
  SYSTEM  
  "http://www-x.antd.nist.gov:8080/  
    p25/issi-emulator/testscripts/dtd/topologyconfig.dtd">
```

```
<issi-tester-config  
>  
<description>
```

A SU in a calling Serving RFSS initiates a SU-to-SU call with a SU in a called Serving RFSS. The calling Home RFSS, the called Home RFSS and the called Serving RFSS do not reject the request coming from the calling Serving RFSS to initiate the SU-to-SU call.

These RFSSs have available resources to set up RTP sessions.

The called SUs radio site does not have a RF resource available and returns busy.

```
</description>
```

Topology Configuration

```
<wacn-config
    wacnName = "wacn_0001"
    wacnId = "0001"
/>
<systemconfig
    systemName = "system_2"
    systemId = "0002"
/>
<!-- The Following describe the RFSSs in the system. -->
<rfssconfig
    rfssName= "rfss_1"
    ipAddress ="127.0.0.1"
    port = "4050"
    rfssId = "1"
    emulated="true"
/>
```

```
<rfssconfig
    rfssName = "rfss_2"
    ipAddress = "127.0.0.1"
    port = "4060"
    rfssId="2"
    emulated = "true"
/>
<rfssconfig
    rfssName="rfss_3"
    ipAddress = "127.0.0.1"
    port = "4070"
    rfssId = "3"
    emulated = "true"
/>
<rfssconfig
    rfssName="rfss_4"
    ipAddress = "127.0.0.1"
    port = "4080"
    rfssId = "4"
    emulated = "true"
    rfResourcesAvailable = "false"
/>
```

```
<suconfig  
  
    suName="su_34"  
    suld="34"  
    homeRfssName = "rfss_3"  
    servingRfssName = "rfss_4"  
    inviteProcessingDelay = "7"  
  
>  
<userprofile>  
<![CDATA[  
u-access:1  
u-dup:1  
u-sec:0  
u-gcall:3  
u-ucall:1  
u-upri:10  
u-iccall:0  
u-icsec:1  
u-icpri:10  
u-authtype:0  
u-availcheck:1  
u-prefsetup:0  
]]>  
</userprofile>  
</suconfig>
```

```
<suconfig
    suName="su_12"
    suld = "12"
    homeRfssName = "rfss_1"
    servingRfssName = "rfss_2"

>
<userprofile>
<![CDATA[
u-access:1
u-dup:1
u-sec:0
u-gcall:3
u-ucall:1
u-upri:10
u-iccall:0
u-icsec:1
u-icpri:10
u-authtype:0
u-availcheck:2
u-prefsetup:0
]]>
</userprofile>
</suconfig>

</issi-tester-config>
```

Demo Test Script

```
<?xml version="1.0" ?>  
<!DOCTYPE test-script SYSTEM "http://www-x.antd.nist.gov:8080/p25/issi-emulator/testscripts/dtd/testscript.dtd">  
<test-script>  
  
<description>  
  
A SU in a calling Serving RFSS initiates a SU-to-SU call with a SU in  
a called Serving RFSS. The calling Home RFSS, the called Home RFSS and  
the called Serving RFSS do not reject the request coming from the  
calling Serving RFSS to initiate the SU-to-SU call.  
These RFSSs have available resources to set up RTP sessions. The called  
SUs radio site temporarily does not have a RF resource available.  
  
</description>
```

```
<!-- This defines the scenario -->
<su-to-su-call-setup-scenario
    id="su-to-su-call-0"
    time = "0"
    callingSuName = "su_12"
    calledSuName = "su_34"

/>

<!-- This defines an action performed by an SU at a particular time
In this case at time 10 seconds, the SU 1,2 tears down the call
-->
<su-script
    id = "su-script0"
    time = "4"
    suName = "su_34"
    method = "doCancelCall"

>

def doCancelCall():
    global su
    su.cancelCallSegment()

</su-script>
```

```
<!-- This defines the post condition that is checked after the test is completed -->  
  
<post-condition  
    scriptingEngine="python"  
    assertion="checkMessages"  
    locationSelector="locationPredicate"  
>  
  
def locationPredicate() :  
    return 1  
  
def checkMessages() :  
    return currentRfss.getRFSS().testCapturedMessages()  
  
</post-condition>  
  
</test-script>
```